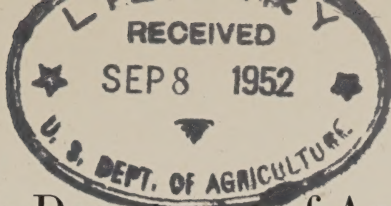


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# United States Department of Agriculture

BUREAU OF PLANT INDUSTRY,

Horticultural & Pomological Investigations.

WASHINGTON, D. C.

## THE RELATION OF WASHING TO DECAY IN WASHINGTON NAVEL ORANGES; SEASON OF 1914-15

### INTRODUCTION.

During the past two or three years there has been a great increase in the washing of oranges in the packing houses of Southern California, and the indications are that a much larger proportion of the fruit will be subjected to this treatment in the future unless effective measures can be used for the control of scale and sooty mold in the orchards.

The results of the investigations of the Bureau of Plant Industry have shown that washing, even under the most favorable conditions, is followed by an increase in the decay in the packed fruit. The process offers ideal conditions for the infection of injured fruits with blue mold, and where washing is employed a higher standard of care in the field and house-handling methods becomes imperative in order to reduce the chances of mechanical injuries in the fruit to a minimum. The packing of moist or wet fruit provides conditions that are very favorable for the development of decay in injured fruit.

During the orange-shipping season of 1914-15, an investigation was conducted by the Bureau to determine the relation of handling to the occurrence of decay resulting from the methods used in the washing and subsequent drying of the fruit. The work was undertaken at the request of the Citrus Protective League and packing house experiments were made in ten different houses during the season.

### ORANGE WASHING AND DRYING EXPERIMENTS.

The handling experiments were planned to make a direct comparison of fruit very carefully picked by the bureau men with the same kind of fruit handled under ordinary commercial conditions. The fruit was packed and held in the packing houses and the percentages of decay in the various lots were determined by inspection at the end of two weeks. The different lots included carefully handled and commercially handled fruit washed in the ordinary machinery, part of which was packed while still moist or wet and an equal amount of fruit which was thoroughly dried before packing. Part of the same fruit was packed without washing or brushing. These experiments

were designed to show the effect of the washing process on the keeping quality of the fruit and to furnish data indicating the percentages of the decay due to the wet or moist condition of the fruit at the time of packing.

The results of these tests are given in Table I and the accompanying diagram—Figure 1.

*Table I.—Average percentages of decay in carefully handled and ordinary commercially handled Washington Navel oranges—1915.*

| Number of Experiments | TREATMENT                       | Carefully Handled | Commercially Handled |
|-----------------------|---------------------------------|-------------------|----------------------|
| 23                    | Not brushed or washed           | Per cent<br>1.8   | Per cent<br>8.3      |
|                       | Washed and thoroughly dried     | 3.4               | 11.4                 |
|                       | Washed and not thoroughly dried | 3.9               | 13.9                 |

*Figure 1.—Diagram showing percentages of decay in Table I.*

|   | Per cent |       |
|---|----------|-------|
| Not Washed—<br>Carefully handled .....                  | 1.8      | —     |
| Commercially handled .....                              | 8.3      | ————— |
| Washed and Thoroughly Dried—<br>Carefully handled ..... | 3.4      | ———   |
| Commercially handled .....                              | 11.4     | ————— |
| Washed—Not Thoroughly Dried—<br>Carefully handled ..... | 3.9      | ———   |
| Commercially handled .....                              | 13.9     | ————— |

The data show that the percentages of decay in carefully handled fruit was increased from 1.8 per cent in the unwashed fruit to 3.4 per cent in the washed and thoroughly dried fruit, and was increased to 3.9 per cent in washed fruit packed wet. In the ordinary commercially handled lots the average percentage of decay in the unwashed fruit was 8.3 per cent. Washing followed by thorough drying increased the decay to 11.4 per cent, and in the same fruit packed wet the average decay was 13.9 per cent. The difference in the percentages of decay developing in the wet and dry-packed fruit was considerably greater during the period of cloudy or wet weather early in the season. The figures given are the averages for the whole season.

#### RELATION OF HANDLING TO DECAY IN WASHED FRUIT

The results indicate that the losses from decay resulting from packing improperly dried oranges are directly in proportion to the care exercised in the methods of handling. Fruit showing a high percentage

of mechanical injuries develops the maximum amount of decay following washing without thorough drying. In the fruit that was picked with sufficient care to avoid serious injuries there was a comparatively small increase in the decay in the lots that were washed and not thoroughly dried before packing. It is probable that a greater difference in favor of very thorough drying would have been shown if more efficient methods of handling the specially dried lots had been available during the early part of the season.

#### METHODS OF DRYING ORANGES.

By heating the air blast used in orange dryers the relative humidity of the air is lowered, which increases its capacity for absorbing the moisture on the surface of the fruit. Experiments were made to determine the time required to dry the fruit under different conditions of temperature and humidity. The humidity of the air was varied by the use of a heating apparatus and by passing the air through a compartment containing calcium chloride. The results of these experiments showing the time required to dry oranges under different conditions of humidity and temperature of the air blast are given in Table II.

*Table II.—Relation of temperature and humidity of the air in promoting the rapid drying of oranges.*

| Temperature of Air Blast | Relative Humidity of Air Blast | Time Required for Complete Drying of Oranges |
|--------------------------|--------------------------------|--|
| 55 Degrees F.            | 70 per cent                    | 11.0 Minutes                                 |
| 55 " "                   | a 57 " "                       | 5.5 "  |
| 63 " "                   | a 40 " "                       | 4.0 "  |
| 76 " "                   | b 30 " "                       | 2.5 "  |
| 82 " "                   | b 22 " "                       | 2.0 "  |
| 82 " "                   | 74 " "                         | 9.5 "  |
| 101 " "                  | c 57 " "                       | 4.0 "  |
| 103 " "                  | b 18 " "                       | 1.7 "  |
| 130 " "                  | c 14 " "                       | 1.2 "  |

NOTE.—

- a—Calcium chloride used.
- b—Calcium chloride and heat used.
- c—Heat used.

The most rapid evaporation of the moisture on the fruit took place with dry air at a temperature of 130 degrees F. The time varied from approximately 11 minutes with an air blast having a temperature of 55 degrees and a relative humidity of 70 per cent to about one minute with air at a temperature of 130 degrees and 14 per cent humidity. The bearing of the data presented in Table 2 on the methods of drying oranges under commercial conditions is shown by the considerable

reduction in the time required for effective results when a dry air blast is used. The use of Calcium chloride in conditioning the air has not yet been demonstrated to be as effective or practicable for this purpose as heat. The temperature of the fruit was not increased materially after two minutes in an air blast at a temperature of 130 degrees.

Experiments were conducted with two different types of dryers. In one of these the roller conveyor was used and the air blast was forced through narrow openings above the fruit which extended across the conveyor parallel to the rollers. The openings were formed by air nozzles about three inches wide, the air apertures being about one-quarter of an inch in width. In the other device a rope conveyor was used and the fruit passed through narrow trough-shaped runs, the air blast being forced on the fruit from the sides and bottom of the runs.

In the experiments conducted with the dryers it was found that infection with blue mold may be increased if the dusty air of the packing house is blown on the fruit in the air blast. In an efficient system of drying the cost of heating the air to a temperature of 130 degrees should not exceed one dollar per car of packed fruit.

This Circular is issued in order to present the results of the investigations promptly at the close of the season's work. The co-operation of the citrus associations and particularly the Pomona Fruit Growers' Exchange was given to the Bureau Investigators throughout the work. In addition the California Fruit Growers' Exchange and the Citrus Protective League shared the expense of conducting the investigation with the Bureau of Plant Industry.

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